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on

A STUDY OF THE FEASIBILITY OF FAST NEUTRON ACTIVATION ANALYSIS  
AS A NONDESTRUCTIVE TESTING METHOD FOR ALPHA PHASE TITANIUM ALLOY

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One of the first objectives in this research project was to determine the nominal bulk oxygen concentration in specimens of good quality titanium alloy (Ti-6Al-4V). This is important since the proposed nondestructive testing procedure is based on the assumption that a map of oxygen concentration in a plate of the material may indicate whether or not massive alpha alloy is present. Ten specimens for this measurement were selected at random from a group of samples taken from an acceptable trim ring by NASA. These specimens, each weighing approximately 2.5 grams, were nondestructively analyzed for their oxygen content using the Mark III system in the Activation Analysis Research Laboratory. The oxygen content of all ten samples was found to be in the range of 0.17 to 0.19 weight percent with an average of about 0.18 weight percent oxygen.

Several samples of the "as received" good Ti-6Al-4V alloy were heat-treated in the laboratory in an attempt to produce a higher concentration of alpha material. A number of different heat-treatment procedures have been tried but none has been completely successful in producing a high alpha alloy. Activation analysis of the treated samples showed an increase in oxygen content with concentrations ranging from .36% to 1.3%. Several specimens were etched to remove the oxide layer from

the surface and then analyzed for oxygen to determine the significance of surface oxide in the total oxygen results. It was found that the oxide contributes less than 10% of the total oxygen. X-ray diffraction measurements will be conducted so that a comparison between oxygen concentration and alpha alloy content can be made.

A key objective of this research work is to determine the feasibility of mapping the oxygen concentration in a titanium alloy plate using fast neutron activation. The widely-used technique of fast neutron activation analysis for oxygen determination is based on the irradiation of oxygen-16 with high energy neutrons to produce nitrogen-16. The high energy gamma radiation emanating from the radioactive decay of 7.3 second nitrogen-16 is then measured. In order to map the oxygen concentration in a plate, it will be necessary to achieve spacial resolution by means of restricting the region of the plate being activated, limiting the region of the plate being viewed by the radiation counter, or by a combination of the two. Two approaches to this problem involve 1) neutron collimation and 2) gamma ray collimation. To determine the feasibility of neutron collimation, experiments were conducted with polyethylene, lead and copper as neutron shielding. The following results

were obtained from the neutron shielding experiments.

<u>Material</u>	<u>Thickness</u>	<u>Observed Attenuation Factor for Neutrons with Energy &gt; 10 MeV</u>
Polyethylene	1½"	0.81
Lead	2½"	0.61
Copper	2"	0.61

Another important and probably overriding factor in the neutron collimation experiment was the 15x reduction in irradiation geometry incurred as a result of moving the sample away from the neutron source 2½ inches. The overall results of this set of experiments indicate that an effective neutron collimator would impose such a serious penalty in irradiation geometry or flux density that the oxygen measurement sensitivity would be totally inadequate for this particular application.

The use of a focusing lead collimator with a 3" x 3" NaI scintillation detector was then considered as a means of measuring nitrogen-16 activity in a localized region of a flat plate. Figure 1 shows a cross-section view of the collimator and detector arrangement along with a curve depicting the response of the counter to gamma ray sources located at different positions on a line perpendicular to the axis of the collimator. Additional tests are planned to determine the feasibility of locating such a detector within 20 feet of the

neutron source at a position where sample transfer could be conveniently accomplished. If the background activity level as seen by the detector is sufficiently low in this position, an oxygen containing plate can be irradiated at the neutron generator and transferred to the detector for counting. An experimental model has been designed to simulate a metal plate with various patterns of non-uniform oxygen distribution. This model will be used to experimentally determine the resolution and sensitivity of the above neutron source and collimated detector arrangement.

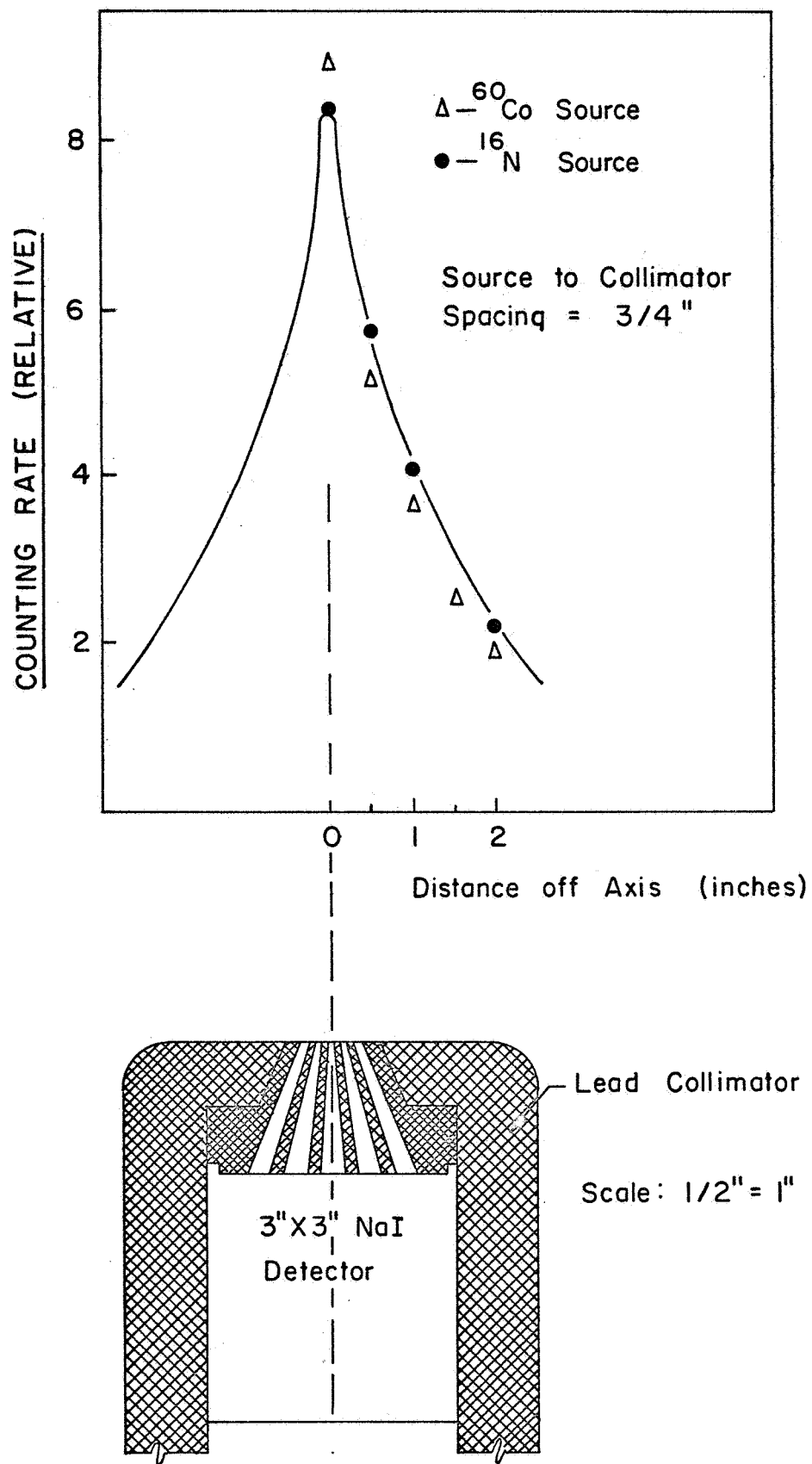


FIGURE 1 RESPONSE OF GAMMA RAY DETECTOR WITH  
FOCUSING LEAD COLLIMATOR